

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

REC'D 24 OCT 2005

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Applicant's or agent's file reference P23355PCAU	FOR FURTHER ACTION	See Form PCT/IPEA/416
International application No. PCT/AU2004/001668	International filing date (day/month/year) 29 November 2004	Priority date (day/month/year) 28 November 2003
International Patent Classification (IPC) or national classification and IPC Int. Cl. ⁷ F01L 9/02		
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1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 4 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
- a. ☒ (sent to the applicant and to the International Bureau) a total of 5 sheets, as follows:
- ☐ sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
- ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
- b. ☐ (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or table related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

- ☒ Box No. I Basis of the report
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☒ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

Date of submission of the demand 28 September 2005	Date of completion of the report 13 October 2005
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer KURT TOBLER Telephone No. (02) 6283 2469

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/AU2004/001668

Box No. I Basis of the report

1. With regard to the language, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
 - ☐ This report is based on translations from the original language into the following language which is the language of a translation furnished for the purposes of:
 - ☐ international search (under Rules 12.3 and 23.1 (b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the elements of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):
 - ☐ the international application as originally filed/furnished
 - ☒ the description:
 - pages 1-3, 5-16 as originally filed/furnished
 - pages* 4, 4a received by this Authority on 28 September 2005 with the letter of 27 September 2005
 - pages* received by this Authority on with the letter of
 - ☒ the claims:
 - pages as originally filed/furnished
 - pages* as amended (together with any statement) under Article 19
 - pages* 17-19 received by this Authority on 28 September 2005 with the letter of 27 September 2005
 - pages* received by this Authority on with the letter of
 - ☒ the drawings:
 - pages 1-7 as originally filed/furnished
 - pages* received by this Authority on with the letter of
 - pages* received by this Authority on with the letter of
 - ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.
3. ☐ The amendments have resulted in the cancellation of:
 - ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to the sequence listing (*specify*):
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
 - ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to the sequence listing (*specify*):

* If item 4 applies, some or all of those sheets may be marked "superseded."

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/AU2004/001668

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims 1-15	YES
	Claims	NO
Inventive step (IS)	Claims 1-15	YES
	Claims	NO
Industrial applicability (IA)	Claims 1-15	YES
	Claims	NO

2. Citations and explanations (Rule 70.7)

Claims 1-15 meet the criteria set forth in PCT Article 33(2) for novelty. The prior art published before the priority date does not disclose a reciprocating piston residing wholly within a housing, a connector passes through an aperture in said housing and the piston sealing with the housing the prevent leakage through the aperture from the first and second reciprocating piston ends.

The prior art discloses pistons having rod connectors extending axially from the piston, hence the connectors are passing through one of the piston end chambers, requiring sealing means to prevent leakage from the one piston end.

The claimed invention is not obvious in the light of any of the cited documents nor is it disclosed in any obvious combination of them. It is also considered that it would not be obvious to a person skilled in the art in the light of common general knowledge either by itself or in combination with any of these documents.

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/AU2004/001668

Box No. VI Certain documents cited

1. Certain published documents (Rule 70.10)

Application No. Patent No.	Publication date (day/month/year)	Filing date (day/month/year)	Priority date (valid claim) (day/month/year)
WO 2003/106820 A1	24 December 2003	31 January 2003	13 June 2002

2. Non-written disclosures (Rule 70.9)

Kind of non-written disclosure

Date of non-written disclosure
(day/month/year)

Date of written disclosure
referring to non-written disclosure
(day/month/year)

the common general knowledge in the relevant art on or before the priority date of the claims herein.

SUMMARY OF THE INVENTION

A first aspect of the present invention provides a valve operating apparatus
5 for an internal combustion engine including:

- a housing;
- a reciprocating piston residing wholly within the housing, the reciprocating piston driving one or more poppet valves;
- a first fluid supply path and a first fluid drain path, each path being
10 controllable to supply or drain fluid to/from a first reciprocating piston end;
- a second fluid supply path and a second fluid drain path each path being controllable to supply or drain fluid to/from a second reciprocating piston end;

wherein said reciprocating piston, in use, is driven between a first position and a
15 second position by controlling said fluid in said supply and drain paths, thereby operating said one or more poppet valves, characterised in that a connector passes through an aperture in said housing to connect said reciprocating piston to said one or more poppet valves, said reciprocating piston in co-operation with an internal wall of the housing forming a seal to prevent substantial egress of fluid
20 through said aperture from the first reciprocating piston end and from the second reciprocating piston end.

In a particularly preferred embodiment, said aperture is substantially sealed by at least a portion of the external surface of said reciprocating piston to prevent egress of fluid from the housing through said aperture.

25 Preferably, said aperture is located in a side wall of said housing, and wherein an external side wall surface of said piston in conjunction with an internal side wall surface of said housing forms said seal to prevent substantial egress of fluid from the housing through said aperture.

Preferably, the longitudinal axis of said connector is substantially
30 perpendicular to the longitudinal axis of said piston.

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Prior hydraulic valve operating apparatus requires a seal between the moving poppet valve stem and the hydraulic fluid supply at the point where the poppet valve stem passes through the housing. Advantageously, the present arrangement avoids such a seal. Instead, the reciprocating piston itself acts as a
5 seal to prevent pressurised fluid from reaching the aperture from within the housing.

Internal friction in the hydraulic valve operating apparatus is lowered, as friction between the reciprocating piston and housing, already present, is not significantly increased when the reciprocating piston is used to prevent leakage of
10 fluid through an aperture in an external wall of the housing.

I CLAIM:

1. A valve operating apparatus for an internal combustion engine including:

- a housing (2);
- a reciprocating piston (1) residing wholly within the housing (2), the reciprocating piston (1) driving one or more poppet valves (7);
- a first fluid supply path (3) and a first fluid drain path (5), each path being controllable to supply or drain fluid to/from a first reciprocating piston end (16);
- a second fluid supply path (4) and a second fluid drain path (6), each path being controllable to supply or drain fluid to/from a second reciprocating piston end (17);

wherein said reciprocating piston (1), in use, is driven between a first position and a second position by controlling said fluid in said supply and drain paths (3, 4, 5, 6), thereby operating said one or more poppet valves (7), characterised in that a connector (9) passes through an aperture (14) in said housing (2) to connect said reciprocating piston (1) to said one or more poppet valves (7), said reciprocating piston (1) in co-operation with an internal wall of the housing forming a seal to prevent substantial egress of fluid through said aperture (14) from the first reciprocating piston end (16) and from the second reciprocating piston end (17).

2. A valve operating apparatus according to claim 1 characterised in that said aperture (14) is substantially sealed by at least a portion of the external surface of said reciprocating piston (1) to prevent egress of fluid from the housing (2) through said aperture (14).

3. A valve operating apparatus according to any one of the preceding claims characterised in that said aperture (14) is located in a side wall of said housing (2), and wherein an external side wall surface of said piston (1) in conjunction with an internal side wall surface of said housing forms said seal to prevent substantial egress of fluid from the housing (2) through said aperture (14).

4. A valve operating apparatus according to any one of the preceding claims characterised in that the longitudinal axis of said connector (9) is substantially perpendicular to the longitudinal axis of said piston (1).

5. A valve operating apparatus according to any one of the preceding claims
5 characterised in that a connector rod (9) fixed to the reciprocating piston (1) connects to one or more poppet valves (7).

6. A valve operating apparatus according to any one of the preceding claims characterised in that said first reciprocating piston end (16) and said second reciprocating piston end (17) have substantially the same surface area.

10 7. A valve operating apparatus according to any one of the preceding claims characterised in that each of said first fluid supply path (3), first fluid drain path (5), second fluid supply path (4) and second fluid drain path (6) has an independently operable control valve (24), said control valve (24) operable to have a closed, partially open or open state, operation of the four said control
15 valves (24) regulating the flow of fluid to said first and second reciprocating piston ends (16, 17), thus enabling control of the movement of the reciprocating piston (1) and hence operation of the one or more poppet valves (7).

8. A valve operating apparatus according to any one of the preceding claims characterised in that a reservoir of high pressure fluid (22) is in fluid connection
20 with one or more of said fluid supply paths (3, 4, 5, 6).

9. A valve operating apparatus according to any one of the preceding claims characterised in that fluid in said supply and drain paths (3, 4, 5, 6) is controlled by an engine management system controller (19), said engine management system controller (19) controlling the operation of the reciprocating piston (1) and
25 thus enabling variable lift and variable timing control of said one or more poppet valves (7).

10. A valve operating apparatus according to any one of the preceding claims characterised in that said reciprocating piston (1) may be decelerated by

controlling said fluid in said supply and drain paths (3, 4, 5, 6) to avoid crashing of said one or more poppet valves (7) onto their respective seats.

11. A valve operating apparatus according to any one of the preceding claims
5 characterised in that said reciprocating piston (1) is biased (12) when in an inoperative state to a predetermined position, thereby biasing each said poppet valve (7) to a predetermined position and the biasing means (12) being prevented from acting on the reciprocating piston (1) when said reciprocating piston (1) is in an operative state.

10 12. A valve operating apparatus according to any one of the preceding claims characterised in that said reciprocating piston (1) is partially hollow, said hollow (18) providing a surface upon which vertical force may act at least at one end (16, 17) of said reciprocating piston (1).

15 13. A valve operating apparatus according to any one of the preceding claims characterised in that said connector (9) connecting the reciprocating piston (1) to the one or more poppet valves (7) allows each poppet valve (7) to spin about its longitudinal axis.

14. An engine including a valve operating apparatus according to any one of the preceding claims.

20 15. A motor vehicle including a valve operating apparatus according to any one of the preceding claims.